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Article

Partner resources and incidence and survival in two major causes of death

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ABSTRACT

Because people tend to marry social equals – and possibly also because partners affect each other's health – the social position of one partner is associated with the other partner's health and mortality. Although this link is fairly well established, the underlying mechanisms are not fully identified. Analyzing disease incidence and survival separately may help us to assess when in the course of the disease a partner's resources are of most significance. This article addresses the importance of partner's education, income, employment status, and health for incidence and survival in two major causes of death: cancer and cardiovascular diseases (CVD). Based on a sample of Finnish middle-aged and older couples (around 200,000 individuals) we show that a partner's education is more often connected to incidence than to survival, in particular for CVD. Once ill, any direct effect of partner's education seems to decline: The survival chances after being hospitalized for cancer or CVD are rather associated with partner's employment status and/or income level when other individual and partner factors are adjusted for. In addition, a partner's history of poor health predicted higher CVD incidence and, for women, lower cancer survival. The findings suggest that various partner's characteristics may have different implications for disease and survival, respectively. A wider focus on social determinants of health at the household level, including partner's social resources, is needed.

Introduction

Research on social inequalities in health has mostly centered on the individual's position in the social structure, and own social standing has repeatedly proven to be a robust predictor of health and mortality. However, horizontal spillovers of socioeconomic resources to family members are understudied in health inequality research (De Neve & Kawachi 2017). The present paper tests the role of having a married or cohabiting partner with great socioeconomic resources, and in good health: Can the other partner take advantage of these resources to improve his/her own health and survival chances? While the association between the social position of one partner and the other partner's health and mortality has been demonstrated (e.g., Monden, van Lenthe, De Graaf & Kraaykamp, 2003; Skalická & Kunst 2008; Torssander & Erikson 2009a,2009b; Brown, Dustin, Robert & Mark, 2014) there is little knowledge about when in the course of disease this association occurs and which type of partner socioeconomic resources matter.

First, it is unclear whether partner resources are primarily related to disease onset and/or the chances of surviving a disease. Partners may influence each other's health behaviors (Monden et al. 2003), for example because of social control and norms concerning lifestyle (Umberson 1987). Further, living with a partner is associated with increased survival chances in certain diseases (Kilpi, Konttinen, Silventoinen & Martikainen, 2015), which may imply that partners assist in various health-care related situations of particular significance for coping with disease. Whether it is beneficial from a treatment perspective to have a partner with rich social and/or material resources is yet uncertain, although some research may point towards such an interpretation (Syse & Lyngstad 2017). To separately analyze disease incidence and survival may help us to assess when in the course of the disease the partner's resources may be of significance, and which underlying processes are more likely.

Second, different socioeconomic resources of the partner (e.g., education and income) may have different links to disease incidence and subsequent survival chances. Many studies have shown that the individual's own education and income have independent associations with health and mortality (e.g., Geyer, Hemström, Peter & Vågerö, 2006; Torssander and Erikson 2010), and it has further been suggested that education is more predictive of the onset of ill health while income is closer linked to its progression (Herd, Goesling & House, 2007).

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However, for partner resources an analysis of different stages of disease comparing various resources has been lacking. Furthermore, one partner's health status may affect the possibility to support the other partner in various health-related situations, as well as being a proxy for the shared lifestyle and health behaviors within the family, which is why the inclusion of partner's health may increase our understanding of the significance of partner characteristics for individuals' health and survival.

In the present study we evaluate these issues by examining the role of a partner's education, employment status, income, and health for disease incidence and survival in CVD and cancer, the first and second leading causes of death (World Health Organization, 2012). Our overarching research questions are: Do some partner characteristics primarily delay the onset of disease? Are these the same partner characteristics that are important to coping with disease and thus predict survival chances?

Partner resources and health

People with more education and higher incomes on average have smaller risks of disease and mortality, which can reflect early life factors and health selection, as well as effects running from education/income to health (Kawachi, Adler & Dow 2010). Education is the starting point for labor market achievements, but given such achievements' own relevance to health, education may also increase "the ability to act on health knowledge" (Pampel, Krueger & Denney, 2010). For example, higher educational attainment may increase the ability to adopt and maintain healthy behaviors, and avoid or give up the unhealthy ones. Income, on the other hand, may be important for health because of access to better material resources and living standards, either in absolute terms or relative to other individuals (Kawachi *et al.* 2010).

It is less clear whether having a partner who has a high education and/or income decreases morbidity and mortality risks. It may be that a partner with advantageous socioeconomic resources has greater possibilities to positively influence family lifestyle, navigate the health care system, and ensure the best possible treatment compared to partners with fewer resources. Still, the correlation between partners' socioeconomic resources and health-related outcomes may also be a consequence of partner choice (Monden 2007). Given the social gradient in health and that partners often have similar socioeconomic positions, particularly educational levels (Kalmijn 1998), it is expected that a partner's socioeconomic position is related to the other partner's health and longevity. In previous research, however, the association between a partner's socioeconomic position and individual mortality risk has not been fully accounted for by own socioeconomic resources (Torssander & Erikson 2009a,2009b), i.e., the association does not only exist because well-educated and wealthy people with good health tend to marry other highly educated, well-off individuals.

Why would a partners' education and income predict the disease and mortality risk on top of one's own socioeconomic resources? Although economic resources may not be equally distributed within a household, both partners' incomes contribute to the overall financial situation in the household, and partner's income could therefore matter for the other partner's health and longevity. Labor market attachment of both partners is further linked to the household's economic situation, but employment status in itself may also affect other family members' health and well-being. For example, unemployment may decrease the mental health of a spouse as much as of the individual (Marcus 2013).

At the individual level, health influences income significantly and more directly, while the health of a partner is likely to influence the income of the other partner to a much smaller extent. In line with this reasoning, a previous study reports that cancer in wives did not impact on men's earnings, and cancer in men mainly affected the wife's earnings in case they became widowed or divorced (Syse, Tretli & Kravdal, 2009). However, an alternative explanation is that a heavy care burden affects participation in paid work.

The sharing of material resources is more tangible than the distribution of non-material resources, but non-material returns to education may also be pooled within households for example via informational support or lifestyle influence between family members. Moreover, transfers of nonmaterial resources do not reduce the resources of the holder, which is the case when monetary assets are further distributed. Since education is associated with lifestyles (Cutler & Lleras-Muney 2010) and studies suggest that partners influence each other's lifestyles (Monden et al. 2003), it is possible that one partner's education has an impact on the other partner's health behaviors, and, subsequently health.

Although not a socioeconomic asset, health can be viewed as a resource in more general terms. Not only may health status influence own employment and income, which in turn may affect other household members' health and well-being, but ill health may further decrease the chances to support and may also be stressful for other family members. Conversely, the potential beneficial effect of a partner's educational attainment and income level on health may operate through partner health (i.e., as a causally intermediate factor between partner's resources and own health[1]). Considering the partner's health status further increases the possibility to adjust for concordance in health behaviors and health between partners: Such associations within couples are clear; the (less) healthy tend to live with the (less) healthy (Meyler, Stimpson, & Peek 2007). Also, both own and partner health may be influenced by unobserved factors and the correlation in health between spouses may stem from partners sharing many external circumstances. Regardless of socioeconomic assortative mating, it is possible that the choice of partner is associated with other health-related characteristics. To our knowledge, the inclusion of both partners' health is rare when studying the effect of one partner's education or income on the other partner's health outcomes (cf. Monden 2007).

Although we may tend to think of partner resources being important to health in the same ways as individual resources are – for example in terms of lifestyle and better material conditions – there are probably also circumstances where the individual resources are of less importance (and partner resources possibly of greater importance). For example, if a serious disease impedes the individual to make use of his/her own resources, the significance of other people's resources and support increases. On the other hand, there are also situations where a spill-over influence from one partner's resources to the other partner's health is less likely. One example of such a situation may be the indirect effect of education on health via occupational hazards and work stress, which primarily affect the individual. Thus, there are likely mechanisms that are more – or perhaps only – relevant for the health of the individual but do not influence the health status of a partner.

Socioeconomic resources and different stages of health problems

In the previous studies contrasting the relative importance of own income and education for onset versus progression of health problems, education seems to be closer related to the early course of health problems and income to its development (e.g., Zimmer & House 2003; Herd et al. 2007). Own education was also a stronger predictor of incidence of myocardial infarction than was income in a recent Finnish study, whereas income was more closely linked with survival (Kilpi, Silventoinen, Konttinen & Martikainen, 2016). Why these different patterns emerge for education and income at different stages of disease is not clear. It has been suggested that educational attainment, generally completed early in the life course, is important for the onset of health problems because of its link to better health behaviors and use of more preventive care. Income, or economic resources in general, may matter more for managing disease including access to health care and

[1] We thank an anonymous reviewer for bringing this to our attention.

Table 1
Number of individuals by partner characteristics: Study subjects in 1997, number of first hospitalizations in 1998–2003 and subsequent deaths due to CVD and cancer in 1988–2007. Finnish men and women (above age 40) with a partner.

	Men								Women							
	CVD				CANCER				CVD				CANCER			
	No. hospitalized		No. of deaths		No. hospitalized		No. of deaths		No. hospitalized		No. of deaths		No. hospitalized		No. of deaths	
	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)
PARTNER'S:																
Education																
High	25 783	2 275	2 145	213	26 881	716	704	278	25 858	1 915	1 885	119	26 602	957	950	237
Intermediate	33 810	3 866	3 619	418	35 695	1 158	1 129	515	27 513	2 213	2 154	147	28 556	867	861	230
Basic	45 583	8 958	8 129	1 657	50 430	3 204	3 072	1 582	47 270	5 838	5 598	630	50 266	2 126	2 085	777
Income quintile																
1. Highest	21 756	2 041	1 936	139	22 707	601	592	227	20 145	1 360	1 338	47	20 700	685	683	160
2	22 098	2 256	2 110	175	23 226	606	593	251	19 720	1 458	1 432	60	20 355	646	640	164
3	21 593	2 829	2 650	387	23 071	950	930	442	20 009	1 869	1 822	137	20 864	773	764	220
4	19 889	3 810	3 472	681	21 969	1 385	1 325	692	20 499	2 455	2 368	260	21 693	925	911	343
5. Lowest	19 840	4 163	3 725	906	22 033	1 536	1 465	763	20 268	2 824	2 677	392	21 812	921	898	357
Employment status																
Employed	60 252	5 510	5 212	365	62 937	1 444	1 421	583	53 109	3 416	3 369	73	54 614	1 518	1512	346
Unemployed	9 440	1 127	1 055	103	9 992	326	318	160	6 875	485	464	18	7 104	215	212	59
Retired	29 749	7 970	7 177	1 766	34 104	3 174	3 034	1 572	38 087	5 894	5 638	798	41 076	2 152	2 109	824
Other	5 735	492	449	54	5 973	134	132	60	2 570	171	166	7	2 630	65	63	15
Hospitalization																
No	81 939	11 067	10 224	1 622	87 470	3 720	3 605	1 751	77 544	7 082	6 858	576	80 692	2 929	2 896	881
Yes	23 237	4 032	3 669	666	25 536	1 358	1 300	624	23 097	2 884	2 779	320	24 732	1 021	1 000	363
All	105 176	15 099	13 893	2 288	113 006	5 078	4 905	2 375	100 641	9 966	9 637	896	105 424	3 950	3 896	1 244

(1) study subjects
(2) events

medications (Herd et al. 2007). Because income levels are fairly unrelated to health care in the Nordic context with universal insurance systems, the latter interpretation is less applicable to the Finnish case (cf. Kilpi et al. 2016). It is possible, however, that limited economic resources reduces the opportunities of coping with disease more generally. Economic stability may for example reduce stress and make it possible to adapt home and work environments in order to manage disease (Herd et al. 2007). Individual income may also be sensitive to the severity of disease and thus predict survival.

In a recent study on partner resources and cancer survival, Syse and Lyngstad (2017) show that survival rates are higher among patients whose partners are well educated and, for women, among patients with high-income partners. Results were fairly similar across cancer sites and stages. For another common disease - myocardial infarction - partner's education independently predicted both incidence and fatality, especially long-term fatality (Kilpi et al. 2018). The relative importance of a partner's education and income depending on stage of disease is however not known. Similar to individual-level resources, we may hypothesize that a partner's education would be of greater importance for disease incidence and income for survival chances. Because of potential negative effects on own income once ill, a partner's income level may be even more important for coping with ill health and recovery possibilities than individual earnings may be. Given educational level, a high partner income level may also be linked with other underlying personal and cognitive characteristics which might be used to improve, not only their own, but also their partner's health.

This said, partner education may of course also be important once the disease has occurred (for example because of its link to health behavior which affects progression) and income to incidence through the possibilities to avoid disease from the very beginning in terms of, for example, exposure to poor environments. To separately look at different stages of disease may yet give indications of possible mechanisms, however, not without attention to these alternative reasons.

Data and Methods

Study sample, follow-up, and outcome measures

Our data consist of a 14% random sample of all persons aged 40 years or older living in private households in Finland at the end of 1997 as well as all their household members. These data were linked to register-based information on socio-demographic factors, dates and causes of deaths for the years 1998–2007 from the population registers of Statistics Finland, as well as information on all hospitalizations between 1995 and 2003 from the National Hospital Discharge Register. The different data sources were linked after ethical approval (TK-53–373-09) using unique personal identification codes available for all permanent residents. We restricted the analyses to individuals who had a co-resident married or cohabiting partner of the opposite sex (114,826 men and 107,169 women).

We examined disease incidence and mortality after incidence separately for CVD (International Classification of Diseases Tenth Revision, ICD10: I00-I99; Ninth Revision, ICD9: 390–450) and cancer (malignant neoplasms; ICD10: C00-C97, ICD9: 140–208). Incidence was defined as having hospital care of any length for CVD or cancer. CVD resulting in death before any hospitalization were included in the incidence analyses but not in the analyses of mortality. Because of changes between the ICD versions, alcoholic cardiomyopathy was not included in CVD (ICD10: I42.6, comprised 0.5% of all CVD deaths). For the CVD incidence analyses, the study sample included individuals with no hospital admission for CVD three years before (1995–1997) the start of the follow-up at 1st of January 1998. After this restriction, analyses on CVD incidence included 105,176 men and 100,641 women. Similarly, we confined the cancer incidence analyses to individuals with no prior hospital admissions for cancer three years before baseline, resulting in a final study sample of 113,006 men and 105,424 women.

The subjects were first followed for CVD incidence defined as the first hospital admission with a primary diagnosis of CVD in 1998–2003.

Table 2
CVD incidence and mortality after incidence among married/cohabiting men: Hazard ratios (HR) and 95% confidence intervals (CI) for partner characteristics (bold = sign.).

	Relative incidence hazard						Relative mortality hazard					
	Model 1		Model 2		Model 3		Model 1		Model 2		Model 3	
	HR	95% CI	HR	95% CI	HR	95% CI	HR	95% CI	HR	95% CI	HR	95% CI
Partner's:												
Education												
Higher (ref.)	1.00		1.00		1.00		1.00		1.00		1.00	
Intermediary	**1.19**	1.13–1.26	**1.09**	1.03,1.15	**1.10**	1.04,1.17	1.17	1.00,1.39	1.03	0.87,1.23	0.94	0.78,1.13
Basic	**1.32**	1.26–1.38	**1.16**	1.09,1.22	**1.17**	1.10,1.24	**1.47**	1.27,1.70	**1.20**	1.02,1.41	1.07	0.90,1.28
Income quintile												
1. Highest (ref.)	1.00		1.00		1.00		1.00		1.00		1.00	
2	**1.10**	1.04–1.17	1.03	0.97,1.09	0.99	0.93,1.06	1.17	0.93,1.46	1.09	0.87,1.36	1.07	0.85,1.34
3	**1.10**	1.04–1.16	1.00	0.94,1.06	0.93	0.88,1.00	**1.58**	1.30,1.92	**1.36**	1.12,1.66	**1.25**	1.01,1.56
4	**1.17**	1.11–1.24	1.02	0.96,1.08	0.93	0.86,1.00	**1.67**	1.38,2.02	**1.34**	1.10,1.63	1.19	0.95,1.49
5. Lowest	**1.19**	1.12–1.26	1.03	0.97,1.10	0.95	0.88,1.02	**1.91**	1.58,2.31	**1.53**	1.26,1.86	**1.35**	1.08,1.69
Employment status												
Employed (ref.)	1.00		1.00		1.00		1.00		1.00		1.00	
Unemployed	**1.13**	1.06,1.20	1.05	0.98,1.12	1.07	0.99,1.15	**1.26**	1.01,1.58	1.07	0.86,1.34	0.96	0.76,1.22
Retired	**1.20**	1.14,1.26	**1.07**	1.02,1.13	**1.08**	1.02,1.15	**1.77**	1.52,2.06	**1.43**	1.23,1.66	**1.29**	1.09,1.53
Other	0.95	0.86,1.04	0.95	0.87,1.04	0.96	0.87,1.07	**1.64**	1.23,2.18	**1.66**	1.25,2.22	**1.41**	1.04,1.92
Hospitalization												
No (ref.)	1.00		1.00		1.00		1.00		1.00		1.00	
Yes	**1.09**	1.05–1.13	**1.08**	1.04,1.12	**1.07**	1.03,1.11	0.96	0.87,1.05	0.94	0.86,1.03	0.92	0.84,1.01

Model 1: Binary models
Model 2: Adjusted for own education, own income, own employment status, and partnership status.
Model 3: Fully adjusted models (same as M2 but with all partner characteristics included simultaneously).

Those who experienced the admission were subsequently followed for CVD mortality until the end of 2007. Altogether, we followed 13,893 men and 9,637 women for CVD mortality. Similarly, 4,905 men and 3,896 women were followed for cancer mortality after being hospitalized for cancer in 1998–2003.

Variables

Education, income, and employment status were measured in identical ways for the individual and his/her partner. The individual measures were included in Models 2 and 3 as control variables.

Education was defined as the highest completed degree or certificate at the end of 1997, categorized into (1) basic education up to 9 years of compulsory schooling, (2) upper secondary education, and (3) tertiary education. Basic education was the most common level in these cohorts and individuals with low-educated partners were over-represented in the mortality analyses because incidence was more common in these groups (see Table 1).

Income quintiles were constructed from information on personal taxable income in the year 1997, and included wages, entrepreneurial and property income, pensions, unemployment and social security benefits. Sex-specific income quintile limits were calculated using the total population of men and women, respectively, at the end of 1997.

Employment status refers to the longest held status in 1997, divided into four categories: (1) employed, (2) unemployed, (3) retired, and (4) other. Employment status reflects the labor market attachment before follow-up and is related to both socioeconomic factors and mortality (Åhs & Westerling 2006).

Partner's hospitalization distinguished between (1) having at least one hospital episode or (2) no hospital episodes due to internal causes (ICD-10 codes: A00-N99, P00-R99), excluding child-birth and pregnancy-related causes, in 1996–1997. About one fourth had a partner who had any hospitalization during these two years. Since most severe diseases are taken care of within hospitals in Finland, hospital admissions may be a proper proxy of severe disease/morbidity. Hospitalizations may further represent a more objective measure of morbidity than self-reports, however, some groups are probably more prone to seek and/or receive care for a given condition (Bygren 2001).

Partnership status takes the value (1) for married individuals living with the spouse, and the value (2) for cohabiting couples (without being married). Statistics Finland classifies as cohabiting couples two unmarried persons living in the same dwelling of at least 18 years of age who are not siblings, of different sex, and with an age difference of less than 16 years. Being married has been found to be more beneficial for men than for women, and cohabitation without being married is even associated with an elevated risk for fatality in myocardial infarction for women (Kilpi et al. 2015). Furthermore, partnership status is associated with socioeconomic conditions (ibid.) and therefore included as a control variable.

Statistical model

We modeled the association between the covariates and the different outcomes with Cox proportional hazards regression. Individual age was used as the time axis to take into account that individuals enter the study at different ages (and age is a strong predictor of disease and mortality). Entry time for the incidence analyses was 1st of January 1998 – i.e., the underlying time variable refers to individuals' age at this date – and exit time was 31st of December 2003. For the mortality analyses, the entry time corresponded to the age at the date of hospitalization and the final follow-up date was 31st of December 2007. Individuals were censored at the time of emigration or death in the incidence analyses, and at the time of emigration or death due to other causes than the outcome (CVD or cancer, respectively) in the mortality analyses. We also censored for partnership status changes, i.e., if a person separated/divorced or if the partner died during follow-up.

Three regression models were performed. Model 1 separately examined the association between each of the partner characteristics (education, income, employment status, and previous hospitalization) and incidence/mortality. Model 2 added controls for individual-level factors (education, income, and employment status) and partnership status, and Model 3 examined the mutually adjusted hazard ratios for

Table 3
CVD incidence and mortality after incidence among married/cohabiting women: Hazard ratios (HR) and 95% confidence intervals (CI) for partner characteristics (bold = sign.).

	Relative incidence hazard						Relative mortality hazard					
	Model 1		Model 2		Model 3		Model 1		Model 2		Model 3	
	HR	95% CI	HR	95% CI	HR	95% CI	HR	95% CI	HR	95% CI	HR	95% CI
Partner's:												
Education												
Higher (ref.)	1.00		1.00		1.00		1.00		1.00		1.00	
Intermediary	**1.19**	1.12,1.27	**1.10**	1.03,1.18	**1.07**	1.00,1.15	**1.41**	1.10,1.79	**1.29**	1.00,1.66	1.08	0.82,1.42
Basic	**1.29**	1.22,1.36	**1.16**	1.09,1.23	**1.11**	1.04,1.19	**1.32**	1.08,1.60	1.13	0.91,1.41	0.91	0.70,1.18
Income quintile												
1. Highest (ref.)	1.00		1.00		1.00		1.00		1.00		1.00	
2	**1.09**	1.01,1.17	1.03	0.96,1.11	1.01	0.94,1.09	1.17	0.80,1.72	1.16	0.79,1.71	1.15	0.78,1.70
3	**1.17**	1.09,1.25	**1.08**	1.00,1.16	1.05	0.97,1.13	**1.51**	1.08,2.12	1.41	0.99,2.00	1.41	0.98,2.02
4	**1.23**	1.15,1.32	**1.11**	1.03,1.19	1.06	0.98,1.16	**1.81**	1.31,2.49	**1.62**	1.16,2.27	**1.65**	1.13,2.40
5. Lowest	**1.32**	1.23,1.41	**1.17**	1.09,1.26	**1.12**	1.03,1.22	**1.90**	1.39,2.60	**1.57**	1.13,2.19	**1.62**	1.11,2.36
Employment status												
Employed (ref.)	1.00		1.00		1.00		1.00		1.00		1.00	
Unemployed	1.02	0.93,1.12	0.99	0.90,1.10	0.94	0.85,1.04	1.48	0.88,2.50	1.35	0.79,2.29	1.09	0.64,1.88
Retired	**1.13**	1.06,1.21	1.04	0.97,1.12	0.99	0.92,1.06	**1.67**	1.21,2.32	1.23	0.88,1.72	1.06	0.75,1.51
Other	1.07	0.91,1.24	1.08	0.93,1.26	1.01	0.86,1.18	1.68	0.77,3.66	1.37	0.62,3.03	1.13	0.50,2.52
Hospitalization												
No (ref.)	1.00		1.00		1.00		1.00		1.00		1.00	
Yes	**1.12**	1.07,1.17	**1.10**	1.06,1.15	**1.10**	1.05,1.15	1.01	0.88,1.16	1.00	0.87,1.14	0.99	0.86,1.14

Model 1: Binary models
Model 2: Adjusted for own education, own income, own employment status, and partnership status.
Model 3: Fully adjusted models (same as M2 but with all partner characteristics included simultaneously).

all predictors. All regressions adjusted for age since this was the underlying time variable in the Cox model.

Results

CVD

For both women and men, the first hospital admission for CVD – hereafter referred to as CVD incidence – was associated with partner's education, employment status, and income (Incidence Model 1, Tables 2 and 3). Having a well-educated, high-income, or employed partner was correlated with lower incidence. If the partner was hospitalized for a disease before the start of the follow-up, the risk of CVD incidence was somewhat greater than if the partner had not been hospitalized, suggesting concordance in ill-health between partners.

Adjusted for all individual characteristics (own education, income, and employment status) as well as partnership status (married or cohabiting), partner's education was still significantly associated with CVD incidence (Incidence Model 2, Tables 2 and 3). A clear part of the relationship between partner education and CVD incidence was however explained by individual-level resources. A partner's income was only related to CVD incidence among women, but not among men, when individual-level factors were controlled for.

When mutually adjusted for all partner characteristics, i.e., also the partner's health, the higher incidence associated with low partner education was still evident for both women and men (Incidence Model 3, Tables 2 and 3). There was also higher incidence among women married to men in the lowest income category, and for men married to retired women (compared to the reference category of employed).

The unadjusted hazard ratios between the partner's education or income and CVD mortality after a CVD hospitalization, were generally larger than the hazard ratios for incidence (Mortality Model 1, Tables 2 and 3). However, whether the partner had previously been admitted to hospital was not associated with CVD survival in either men or women.

Control for own resources (Mortality Model 2, Tables 2 and 3) attenuated the associations between the partner characteristics and CVD mortality as expected, yet, although weakened, many associations remained. In the fully adjusted model (Mortality Model 3, Tables 2 and 3), partner income was related to CVD mortality among both men and women, but the differences by partner education were no longer significant. For men, having a female partner who had left gainful employment was also related to excess mortality.

Cancer

Two of our examined factors, the female partner's education and employment status, were associated with incidence of any malignant neoplasms/cancer among men: Having a partner with the lowest educational level was associated with a 10% (95% CI: 2–20%) higher cancer incidence compared to men who had a partner with tertiary education (Incidence Model 1, Table 4). Excess incidence was also found among men with retired partners. However, neither the female partner's income nor her previous hospitalization were linked to the male partner's cancer incidence. The greater cancer incidence among men with a low-educated or retired partner was also significant in the fully adjusted model (Incidence Model 3, Table 4). However, there were no associations between the man's own education or income and cancer incidence in this fully adjusted model (not shown).

For women, we found a reversed association between partner income and overall cancer incidence (Incidence Model 1, Table 5), i.e., having a partner with an income in the lowest fifth was associated with lower incidence. Yet, this association did not remain significant after adjusting for individual-level resources. Whether one partner experienced hospitalization before the follow-up period was not associated with cancer incidence of the other partner for either men or women.

After hospitalized for cancer, mortality was lower for people who had a partner with tertiary education and high income, compared to people with less such resources (Mortality Model 1, Tables 4 and 5) and

Table 4
Cancer incidence and mortality after incidence among married/cohabiting men: Hazard ratios (HR) and 95% confidence intervals (CI) for partner characteristics (bold = sign.).

	Relative incidence hazard						**Relative mortality hazard**					
	Model 1		Model 2		Model 3		Model 1		Model 2		Model 3	
	HR	95% CI	HR	95% CI	HR	95% CI	HR	95% CI	HR	95% CI	HR	95% CI
Partner's:												
Education												
Higher (ref.)	1.00		1.00		1.00		1.00		1.00		1.00	
Intermediary	1.06	0.96,1.16	1.06	0.96,1.17	1.08	0.97,1.20	**1.30**	1.12,1.50	1.08	0.92,1.26	1.00	0.85,1.19
Basic	**1.10**	1.02,1.20	**1.10**	1.00,1.21	**1.12**	1.01,1.24	**1.66**	1.46,1.89	**1.29**	1.12,1.50	1.16	0.99,1.37
Income quintile												
1. Highest (ref.)	1.00		1.00		1.00		1.00		1.00		1.00	
2	0.98	0.87,1.10	0.97	0.87,1.09	0.95	0.85,1.07	1.18	0.98,1.41	1.08	0.90,1.30	1.05	0.87,1.27
3	1.03	0.93,1.15	1.02	0.92,1.14	0.96	0.85,1.08	**1.50**	1.27,1.76	**1.30**	1.10,1.53	1.16	0.97,1.40
4	1.02	0.92,1.13	1.00	0.90,1.11	0.91	0.81,1.04	**1.73**	1.48,2.02	**1.41**	1.19,1.65	1.19	0.98,1.45
5. Lowest	1.02	0.92,1.14	1.00	0.90,1.12	0.93	0.81,1.05	**1.87**	1.60,2.19	**1.49**	1.26,1.75	**1.28**	1.05,1.56
Employment status												
Employed (ref.)	1.00		1.00		1.00		1.00		1.00		1.00	
Unemployed	1.08	0.96,1.22	1.06	0.94,1.20	1.08	0.94,1.24	**1.42**	1.19,1.70	**1.25**	1.04,1.49	1.10	0.91,1.35
Retired	**1.12**	1.03,1.23	**1.10**	1.00,1.20	**1.12**	1.01,1.24	**1.82**	1.60,2.07	**1.50**	1.32,1.71	**1.35**	1.16,1.57
Other	0.95	0.80,1.13	0.95	0.79,1.13	0.97	0.80,1.17	1.10	0.84,1.43	1.07	0.82,1.40	0.91	0.68,1.21
Hospitalization												
No (ref.)	1.00		1.00		1.00		1.00		1.00		1.00	
Yes	0.98	0.92,1.04	0.98	0.92,1.04	0.97	0.91,1.04	1.03	0.94,1.13	1.01	0.92,1.11	0.99	0.90,1.08

Model 1: Binary models
Model 2: Adjusted for own education, own income, own employment status, and partnership status.
Model 3: Fully adjusted models (same as M2 but with all partner characteristics included simultaneously).

these associations were also significant when adjusted for own resources (Mortality Model 2, Tables 4 and 5). For men, partner income and employment status were linked to mortality also when simultaneously adjusted, though with weakened effects (Mortality Model 3, Table 4). For female cancer patients, the partner's employment status (retired compared to being employed) was associated with survival net of the other factors. The education of the partner was however not significantly associated with cancer mortality in either men or women in the fully adjusted model. Lastly, cancer mortality among women was positively associated with the partner's previous hospitalization but this was not the case for the men.

Table 5
Cancer incidence and mortality after incidence among married/cohabiting women: Hazard ratios (HR) and 95% confidence intervals (CI) for partner characteristics (bold = sign.).

	Relative incidence hazard						**Relative mortality hazard**					
	Model 1		Model 2		Model 3		Model 1		Model 2		Model 3	
	HR	95% CI	HR	95% CI	HR	95% CI	HR	95% CI	HR	95% CI	HR	95% CI
Partner's:												
Education												
Higher (ref.)	1.00		1.00		1.00		1.00		1.00		1.00	
Intermediary	0.91	0.83,1.00	0.94	0.86,1.04	0.97	0.87,1.07	1.19	1.00,1.43	1.01	0.83,1.23	0.95	0.78,1.17
Basic	0.93	0.86,1.01	0.97	0.89,1.06	1.00	0.91,1.11	**1.60**	1.38,1.86	**1.24**	1.05,1.46	1.13	0.93,1.36
Income quintile												
1. Highest (ref.)	1.00				1.00		1.00		1.00		1.00	
2	0.95	0.85,1.06	0.97	0.87,1.08	0.98	0.87,1.09	1.15	0.92,1.42	1.03	0.83,1.29	1.00	0.80,1.26
3	0.95	0.86,1.05	0.98	0.88,1.09	0.98	0.87,1.10	**1.24**	1.01,1.52	1.04	0.84,1.29	0.96	0.76,1.21
4	0.91	0.82,1.01	0.94	0.84,1.05	0.94	0.82,1.06	**1.59**	1.31,1.93	**1.26**	1.02,1.55	1.10	0.86,1.41
5. Lowest	**0.88**	0.79,0.98	0.91	0.81,1.02	0.91	0.79,1.03	**1.92**	1.58,2.33	**1.39**	1.12,1.72	1.23	0.95,1.58
Employment status												
Employed (ref.)	1.00		1.00		1.00		1.00				1.00	
Unemployed	0.98	0.84,1.13	0.98	0.84,1.13	1.02	0.87,1.19	1.29	0.98,1.71	1.17	0.88,1.56	1.04	0.77,1.42
Retired	1.00	0.90,1.10	0.99	0.90,1.10	1.02	0.91,1.14	**1.77**	1.48,2.12	**1.44**	1.20,1.74	**1.29**	1.05,1.59
Other	0.92	0.72,1.18	0.91	0.71,1.17	0.97	0.75,1.25	1.28	0.76,2.14	1.17	0.69,1.97	1.00	0.59,1.71
Hospitalization												
No (ref.)	1.00		1.00		1.00		1.00					
Yes	0.99	0.92,1.07	0.99	0.92,1.07	1.00	0.93,1.07	**1.25**	1.11,1.42	**1.21**	1.07,1.37	**1.17**	1.03,1.33

Model 1: Binary models
Model 2: Adjusted for own education, own income, own employment status, and partnership status.
Model 3: Fully adjusted models (same as M2 but with all partner characteristics included simultaneously).

Supplementary cancer analyses

Because of the large variation in the social gradients across cancer sites, where for example breast cancer incidence is positively associated with individual socioeconomic indicators, we conducted stratified analyses for some cancers (not shown in tables). Among women, having a partner with low income was related to low breast cancer incidence, but also to lower survival chances after incidence. On the contrary, lung cancer incidence among men was clearly negatively related to the partner's education in a fully adjusted model. A high partner income was however not a protective factor in lung cancer survival, rather, opposite results were found. Because of low numbers in the analyses for most specific cancer sites, these results should however be interpreted with caution. A further analysis where we controlled for the most common cancer sites in the mortality follow-up revealed fairly identical results to the mortality analyses in Tables 4 and 5. These can be found in Supplementary Table A. Nevertheless, we should keep in mind that the overall picture for cancer incidence and survival encompasses a variety of different sites with their specific etiologies.

Discussion

Summary and originality of the main findings

While we already knew that one partner's socioeconomic position is related to the other partner's overall health and mortality, this study adds to the existing knowledge because of the closer examination of two different stages of disease: incidence and survival. The analyses were carried out on a nationally representative register-based sample of approximately 200,000 cohabiting or married individuals in Finland with no recent prior hospital admission.

For cardiovascular diseases among men, the female partner's education, but not her income, was associated with disease incidence in mutually adjusted models. However, once hospitalized for CVD, the female partner's income rather than her education predicted CVD survival in men. We found a similar result among women, but with the addition that the male partner's income also showed an independent association with CVD incidence. We further demonstrated that CVD incidence, but not survival, was associated with the partner's health. Living with a retired partner was also associated with increased CVD incidence among men.

Previous research has usually concentrated on the association between individual socioeconomic position and CVD (e.g., Lee, Paultre & Mosca, 2005; Marmot, Bosma, Hemingway, Brunner & Stansfeld, 1997; McFadden, Luben, Wareham, Bingham & Khaw, 2008), sometimes separating between different stages of disease (Kilpi et al. 2016). That the partner's education and income yielded somewhat dissimilar patterns for CVD incidence and survival has to our knowledge not been shown before. While the present study focuses on larger disease groups and overall patterns, recent results on the relationship between myocardial infarction and partner's education align well with our results (Kilpi et al. 2018). We add to this knowledge by showing that different aspects of a partner's socioeconomic resources may have unique effects depending on the stage of disease.

For cancer, there were contrasting patterns for incidence and survival among women. While overall cancer incidence was not (or was slightly reversely related) to partner's socioeconomic resources, the chances of surviving cancer was better for women with well-educated, healthy, well-off, and employed male partners (net of the corresponding own socioeconomic resources). For men, differences in cancer incidence by partner's education and employment status were also observed.

Having a highly educated spouse has recently been shown to improve cancer survival, net of own resources (Syse & Lyngstad 2017). We also found such an association, however, when the partner's income and employment status were examined simultaneously, these factors were of greater significance for cancer survival than the partner's education.

Interpretation of the findings

The net effect of a partner's education for CVD incidence, and cancer incidence for men, could have several explanations. Lifestyle differences, not only linked to own education but also to the partner's education, is one possible explanation. For example, partner's education is associated with lower risks of smoking, even after controlling for one's own education (Monden et al. 2003). The association between one partner's previous hospitalization(s) and the other the other partner's CVD incidence further suggests that there is a tendency towards disease which is shared between partners.

When all partner characteristics were mutually adjusted, partner's education yielded no significant associations with survival after hospitalization for a disease. Thus, additional skills, information or lifestyle spill-overs linked to one partner's educational level do not seem to have clear effects in these later disease stages. This does not seem consistent with suggestions that the partner's education-specific knowledge increases the chances of survival because of better treatment (or greater adherence to treatment). However, education may be important in early contact with the health care, and early detection, which may reduce the likelihood of being hospitalized in the first place.

Partner's income and/or employment status (but not education) was linked to survival in both women and men in mutually adjusted models. Thus, any effect of the partner's education on survival chances runs through employment or income returns to education, i.e., as an indirect effect. Although individual income tends to decrease with episodes of ill-health, the effect is likely lower on the partner's income (net of his/her employment status). Tentatively we thus suggest that the better survival chances of individuals with a high-income partner, regardless of the type of the disease, are not mainly explained by an influence of one partner's illness on the other partner's income (remember also that a proxy for partner morbidity is taken into consideration and that partner income is measured before follow-up). Possibly, a partner's income may bring financial stability to the household which may be important for the spouse with a severe disease in terms of, for example, less stress and better circumstances for recovering for ill individuals with limited possibilities to support for themselves. Yet, more research is needed to uncover selective elements that were not possible to control for in the present study as well as factors that may mediate the association between partner income and survival.

Another explanation could be that the partner's employment status and income either reflects or influences pre-hospital factors such as stage at diagnosis and comorbidities, both significant to survival (and not measured in our data). For example, high-income partners may have greater ability to motivate partners to seek early care. It is also possible that the health care system is not fully equal; having a high-income partner who is active in the labor market may increase the individual's chances of receiving fast and effective treatments, e. g, through check-ups at private clinics. Still, municipal health care is tax-funded in Finland and a partner's income is therefore not decisive for receiving health care. High income may also involve power and possibilities to engage in the partner's treatment once hospitalized for a disease.

A partner's weak attachment to the labor market seemed to be linked to, in particular, men's disease and survival. It has been suggested that employment status should be viewed as a dimension of inequality "in its own right" (Richards & Paskov 2016) and may be beneficial through, for example, inter-personal contacts, social capital, and opportunities for skill use. This could also extend to a partner, if for example, employed individuals have a greater social network from which they can receive support and expert knowledge.

For female cancer patients, the health of the partner was associated with survival. This suggests that not only the socioeconomic position of the partner, but also his health status, could be viewed as potentially important for survival chances. However, this result goes against expectations based on traditional gender roles. The fact that women

dedicate more time to caregiving than men would lead us to suggest that her illness has more adverse effects on partner's health than his illness, and this was not the case. On the other hand, the double burden of own and partner's illness with the coexistent care burden may be particularly harsh for women. Thus, a partner's ill health may both mean less support, but also more strain. However, we did not have information about partner's hospital admissions during the survival follow-up and current disease was therefore not covered. Moreover, differences in common cancer sites between women and men make clear-cut comparisons difficult. Information on the health of the partner is however valuable as its functions as an indirect control for health problems shared within households.

Limitations

The present study does not provide direct causal answers. Choice of partner is not a random process but rather based on various characteristics that may directly or indirectly be linked to health and survival chances. However, some potentially important factors for both partner choice and disease/mortality were controlled. Importantly, the socioeconomic side of assortative mating - that people have a tendency to marry within their own socioeconomic group - is to a considerable extent taken into consideration since education, income, and employment status were adjusted for. We therefore conclude that the associations that we observed are unlikely to be due to a partner choice based on socioeconomic factors. It should be noted, however, that effects of partner characteristics become weaker (or sometimes even disappear) when adjusted for individual resources. Thus, assortative mating is indeed *one* important underlying explanation. Further, we excluded individuals with a previous hospitalization for CVD or cancer incidence (excluding any individual who was already ill enough for inpatient care) and accounted for the partner's hospital admission for a disease. Thus, some of the accumulation of health problems within families were also taken into consideration. Other selective processes are harder to examine here, although we do not suffer from non-response bias (e.g., that socioeconomically (dis)advantaged groups with ill-health are less likely to participate) since we rely on administrative register data with good coverage and small measurement errors.

Two more limitations can be noted. First, while this is a first step towards the understanding of partner resources in overall cancer incidence, we should keep in mind that the variations between cancer sites are substantial. A control for the most common cancer types did however not considerably alter our findings. In addition, we did not separate short- from long term mortality risks after hospitalization because of the limited follow-up. Such analyses may give us even more insight on why some partner resources are linked to survival. Second, because the included socioeconomic dimensions are closely related it may be difficult to obtain stable estimates. The strongest bivariate associations were found between income and employment status. We thus calculated the variance inflation factor (VIF) to identify problems with multicollinearity. The VIF values were at maximum 2.33, indicating no severe multicollinearity.

Concluding comments

We demonstrated that the resources that a partner possesses are often associated with individuals' disease and survival, net of own resources. This is in line with results from several previous studies (e.g., Martikainen 1995; Monden 2007; Skalická and Kunst 2008; Syse & Lyngstad 2017). What is more novel, however, is that we showed that different partner characteristics have different implications depending on the stage of disease. For example, a partner's education was more closely connected to the risk of a first hospitalization than to subsequent survival chances. Conversely, a partner's income generally predicted survival but not incidence (especially for men). Our results on partner's health and employment status further demonstrated the complexity of the associations between partner characteristics and health.

By not considering a co-residing partner's socioeconomic position, we risk underestimating social gradients in disease incidence and survival. Furthermore, if individuals are increasingly likely to marry social equals as some studies suggest (Schwartz & Mare 2005), and if there continues to be a robust family-effect on significant diseases and survival, health inequalities are also likely to increase. To shift the attention to the family-level determinants of health may not only deepen our theoretical understanding of health inequalities, but also improve our chances of successful public health policies.

Ethics statement

Our data consist of a 14% random sample of the Finnish population. These data were linked to register-based information on socio-demographic factors, dates and causes of deaths from the population registers of Statistics Finland, as well as information on hospitalizations from the National Hospital Discharge Register. Data linkage was performed by Statistics Finland using unique personal identification numbers and then anonymized for research purposes. Permission to use the data for research was granted by Statistics Finland (approval number TK-53–373-09).

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Appendix A. Supporting information

Supplementary data associated with this article can be found in the online version at http://dx.doi.org/10.1016/j.ssmph.2018.03.001.

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